U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE UNIVERSITY OF MISSOURI AGRICULTURAL EXPERIMENT STATION, F. B. MUMFORD, DIRECTOR; M. F. MILLER, IN CHARGE SOIL SURVEY.

SOIL SURVEY OF LINCOLN COUNTY, MISSOURI.

BY

A. T. SWEET, IN CHARGE, AND H. W. HAWKER, OF THE U. S. DEPARTMENT OF AGRICULTURE, AND E. W. KNOBEL AND J. B. FEHSENFELT, OF THE UNIVERSITY OF MISSOURI.

THOMAS D. RICE, INSPECTOR, NORTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1917.]

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., December 1, 1919.

SIR: In the extension of the soil survey in the State of Missouri work was undertaken in Lincoln County and completed during the field season of 1917.

The accompanying report and map cover this survey and are submitted for publication as advance sheets of Field Operations of the Bureau of Soils for 1917, as authorized by law. This work was carried on in cooperation with the University of Missouri Agricultural Experiment Station.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

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SOIL SURVEY OF LINCOLN COUNTY, MISSOURI.

By A. T. SWEET, In Charge, and H. W. HAWKER, of the United States Department of Agriculture; and E. W. KNOBEL and J. B. FEHSENFELT, of the University of Missouri.—Area Inspected by THOMAS D. RICE.

DESCRIPTION OF THE AREA.

Lincoln County lies in the eastern part of Missouri, about 40 miles northwest of St. Louis. It is bounded on the east by the Mississippi River, which separates it from the State of Illinois. The land area is 607 square miles, or 388,480 acres.

The county comprises three rather distinct topographic divisions. The nearly level or gently undulating uplands, which occupy small areas in the southwestern and northwestern parts of the county; the extensive undulating, hilly, and somewhat broken areas, which extend from the upland regions to the stream valleys; and the stream bottom lands, which include the nearly level flood plains and terraces.

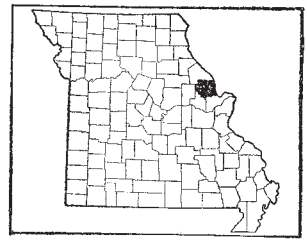

FIG. 1.—Sketch map showing location of the Lincoln County area, Missouri.

The upland area, which enters the county in the northern part, has a maximum elevation of about 800 feet above sea level. East of Whiteside this upland reaches a maximum width of nearly 3 miles. As it extends south it divides, one branch continuing southward to Old Alexandria and the other extending southeastward toward Brussels. A third branch extends southwest from Whiteside. This upland as a whole forms the divide between streams which flow east into the Mississippi River and those which flow south into Cuivre River. The upland area, in the southwest part of the county, with a maximum elevation of about 750 feet, forms the divide between Big Creek and the West Fork of Cuivre River. It extends from near the west line of the county almost to Troy. The third upland area has a maximum elevation of only about 700 feet. It forms the divide between Cuivre River and Lead Creek. From each of these larger upland tracts numerous smaller areas, usually somewhat more undulating, extend out between the smaller tributary streams.

The flood plain of the Mississippi River has an elevation above sea level of slightly less than 450 feet, and consequently lies 250 to 350

feet below the principal upland regions. Since at one time a nearly level plain doubtless extended over this entire region at the level of the present upland remnants, this difference in elevation represents the work of erosion.

The topography over the greater part of the county ranges from undulating or rolling, as on the upland divides, to quite rough and broken, as around the heads of some of the smaller streams and in places along the valleys of the larger streams. The rougher areas occur where the streams have cut back into the limestone beds. Where the underlying beds are massive limestone or where the areas have been covered by glacial material the slopes are more gradual. In the eastern part of the county a thin deposit of loess has modified the topography, making it slightly more rounded. This undulating topography is well shown in Plate I.

In parts of the upland lime sinks are numerous. Some of these have outlets and receive the drainage of small streams, while others either have no outlet or the outlet has become obstructed, the sink being converted into a circular pond. Many sinks occur on the high hills about 2 miles south of Dameron and in the region northeast of Briscoe.

Along the outer edges of the larger valleys broad, low deltas have been built up in places by material deposited by small tributary streams. In a few places there are high terraces, which represent older flood plains. Old Monroe is situated on a terrace of this kind and the town of Elsberry is situated partly on such a terrace. Another one extends southeast from Brevator. The valley of Cuivre River below the junction of North and West Forks of Cuivre River has an average width of nearly a mile. About one-half of this is occupied by a high terrace, 20 to 30 feet above the present flood plain, and part of the remainder of the valley is occupied by lower terraces. Above the junction of these two streams the valley is not so wide, but terraces occur in many places.

Within the flood plain of the Mississippi River there are numerous long, narrow lakes. Some of these are permanent, but many of them exist during the wet season only. Kings Lake, the largest of the permanent lakes, is one-eighth to one-fourth of a mile wide and nearly 5 miles in length. Above the head of the lake the depression extends as a meandering slough, which has been converted into a drainage ditch by dredging. The flood plain contains numerous crooked channels of sluggish streams and a number of large dredged ditches. Near these channels there are in many places long, low ridges, 1 to 3 feet higher than the adjacent land.

Lincoln County is well drained. The North and West Forks of Cuivre River unite about 3 miles north of Troy to form Cuivre River, which with its numerous tributaries drains about two-thirds of the

county. The extreme southwestern section is drained by Big Creek, which forms a part of the southern boundary. The eastern part of the county is drained directly into the Mississippi through Bryants Creek, Lost Creek, and several smaller streams. Branch streams reach into practically every part of the upland. In many places along Cuivre River there are perpendicular bluffs and steep slopes 100 to 150 feet in height, showing the depth to which these streams have worked, yet even these older streams have swift currents and have not reached grade except in the extreme lower parts of their courses near the Mississippi flood plain.

Permanent settlement in this region began a little more than 100 years ago, the first settlements being made in the forested parts of the county, and mainly along the stream courses. Before this time, however, numerous Spanish grants, some of which date far back into the eighteenth century, had been made within the present limits of the county. Some of these old grants include the most productive parts of the county and many of the grant boundaries still serve as land lines. The prairie lands were for a long time supposed to be of little value except for grazing, and most of the upland prairie has been under cultivation for only about 40 years. The open grass-covered lands or "prairies" of the Mississippi bottoms have been under cultivation for a much shorter time, and part of this land has not yet been cultivated.

Most of the early settlers came from Kentucky and Virginia, although some came from Tennessee and a few from States north of the Ohio River. There are also numerous descendants of the early French pioneers. The principal early foreign immigration, however, was of German origin. Between 1830 and 1850 large numbers of Germans settled in this region, especially in the southern and southeastern parts of the county, and their descendants constitute an important part of the present population. During the last 15 or 20 years there has been considerable immigration from Illinois and Iowa and other northern and eastern States.

In 1910 the population of Lincoln County was 17,033, all of which was classed by the census as rural, there being no town of 2,500 population. Settlement is fairly even throughout the county. The largest towns are Troy, the county seat, in the south-central part of the county, and Elsberry, in the northeastern part. Each has an estimated population of about 1,500. Other towns are Winfield, Old Monroe, Foley, and Hawk Point on the Chicago, Burlington & Quincy Railroad; and Silex, Whiteside, Moscow Mills, Briscoe, and Davis on the St. Louis & Hannibal. The principal inland towns are Olney, Truxton, and Louisville.

Three lines of railroad cross Lincoln County. The Chicago, Burlington & Quincy follows the outer edge of the Mississippi flood plain

across the county; another branch of the Chicago, Burlington & Quincy extends from Old Monroe to Mexico, crossing the southern part; and the St. Louis & Hannibal crosses the central part.

Systems of toll roads controlled by local companies radiate from Elsberry, Troy, and Silex. These roads are graded and surfaced with stream gravel. Many of the roads are not at present in good condition, but there is an abundance of good road-building material in nearly all parts of the county, and the main roads are being rapidly improved. Telephone lines and rural mail delivery routes reach all parts of the county.

St. Louis is the principal market for all the agricultural products of the county. Kansas City and Omaha are drawn upon to some extent for live stock for feeding purposes.

CLIMATE.

The climate of Lincoln County, like that of all northeastern Missouri, is temperate and well suited to general farming and stock raising. Serious injury to crops or stock from extremes of climate is of rare occurrence.

There is no Weather Bureau station in Lincoln County, but the records of the station at Louisiana, in Pike County, are believed to be representative. The mean annual precipitation at Louisiana, according to records covering a period of over 30 years, is 34.97 inches. This is well distributed throughout the year. The heaviest precipitation occurs during the months of May, June, and July, when it is most needed. Some injury to crops in the spring occasionally results from excessive rains followed by a few weeks of very dry weather, and periods of drought during July and August sometimes cause diminished yields. Injury from both causes may largely be prevented by proper drainage and the conservation of soil moisture by means of deep plowing followed by thorough cultivation. Spring floods often damage or even destroy crops on the bottom lands.

The average date of the last killing frost in the spring, as recorded at Louisiana, is April 21, and that of the first in the fall, October 12. The latest killing frost recorded in the spring occurred on May 7, and the earliest in the fall on September 13. There is an average growing season of 173 days. This is ample for the maturing of all the ordinary farm crops, and it permits the growing of such crops as cowpeas following wheat or early potatoes. Alfalfa can usually be cut three times, and bluegrass often affords excellent pasturage until the last of November. Fruit is sometimes injured by a heavy frost following warm weather in the early spring, but the crop is rarely a total failure. Complete losses are more often due to lack of proper care than to unfavorable climatic conditions.

CHARACTERISTIC UNDULATING TOPOGRAPHY OF A LARGE PART OF LINCO

This photograph shows the upland as it appears, looking west from a point near Elsberry. The soil

The following table gives the normal monthly, seasonal, and annual temperature and precipitation as recorded at the Weather Bureau station at Louisiana:

Normal monthly, seasonal, and annual temperature and precipitation at Louisiana, Pike County.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*
December	31.0	70	−22	1.86	1.60	1.65
January	27.7	77	−27	2.06	.95	7.44
February	28.1	79	−23	2.49	.35	1.26
Winter	28.9	79	−27	6.41	2.90	10.35
March	42.6	94	− 2	2.59	1.18	1.67
April	53.4	93	19	3.01	3.40	1.28
May	63.9	95	26	4.47	.92	10.01
Spring	53.3	95	− 2	10.07	5.50	12.96
June	71.6	100	34	4.19	1.70	5.31
July	76.2	104	44	3.53	2.10	.28
August	74.9	104	38	2.91	2.45	14.86
Summer	74.2	104	34	10.63	6.25	20.45
September	67.9	105	25	3.33	1.65	3.12
October	55.8	96	12	2.27	2.05	1.82
November	44.1	87	4	2.26	3.20	1.91
Fall	55.9	105	4	7.86	6.90	6.85
Year	53.1	105	−27	34.97	21.55	50.61

AGRICULTURE.

The earlier settlers in this territory located in the valleys and on the lower uplands near the streams, where the soils were most fertile and wood, water, and game abundant. Only the cleared and cultivated fields were fenced. Cattle raising proved profitable and in a short time large herds were grazed on the open prairies. The cattle were cared for by herders until the fall, when the fat animals were driven or shipped to market, the younger cattle being kept for the next year. The open range gradually became poorer and large tracts were bought and fenced for pasture. Close grazing resulted in the killing out of the native bluestem grass, but this was quickly succeeded by bluegrass. A few of these old bluegrass pastures have been under cultivation only within the last few years. The closing of the range and the division of the land into smaller holdings

gradually resulted in an increase in grain farming and a corresponding decrease in live-stock production. As land values have advanced it has been found more profitable to buy much of the live stock for feeding purposes than to raise the young stock at home.

The agriculture of Lincoln County at present consists of grain production, combined with live-stock raising and feeding, and supplemented by dairying. All the products except wheat are marketed in the form of the finished product, mainly fat cattle, hogs, cream, and milk. In the grade of cattle and hogs, as well as in the large number raised and fed, the county ranks high, and Lincoln County stock often commands fancy prices on the markets of St. Louis and Chicago. Hereford, Shorthorn, Holstein, and other breeds of cattle, Poland-China and Duroc-Jersey hogs, and mules and driving and saddle horses all receive the attention of breeders and farmers.

In 1909 the income from live stock and live-stock products was as follows: Animals sold or slaughtered, $1,655,031; dairy products, $81,478; poultry and eggs, $463,065; and wool, $10,880. Horses and mules are raised on practically every farm, and many farmers keep two or more brood mares. Sheep or goats are kept on about one-fourth of the farms. The live stock on the average farm consists of 6 to 10 horses and mules, 10 to 25 cattle, 30 to 50 hogs, 100 to 300 chickens, and in some cases 10 to 25 sheep.

During the last 10 or 15 years the dairy industry has made marked progress. A creamery has been established at Winfield and considerable cream and milk are shipped regularly to Winfield or to St. Louis from almost every shipping point within the county. There are few large dairy herds, but many farmers milk from 6 to 20 cows. Some Jersey cows are used for dairy purposes, but Holsteins are used to a much greater extent, and there are many high-grade and registered Holstein cows. The extension of the dairy industry has been somewhat detrimental to cattle raising through the mixing of dairy breeds, especially the Jersey, with beef types.

Poultry products are an important source of income to a large majority of the farmers. There are no farms devoted exclusively to poultry raising, but on almost every farm there is considerable poultry, and much attention is paid to purebred strains.

Corn is the most important crop in Lincoln County. The area planted ranges from 50,000 to 70,000 acres, and the average annual yield varies from 22 to over 35 bushels per acre. The area reported in corn in 1917 [1] was 53,882 acres. Corn is grown extensively in the Mississippi bottoms and on the lower bottom land along Cuivre River and the smaller streams. There is also a large area in corn on the upland prairies, and it is grown to a greater or less extent on

[1] Missouri Crop Report, 1917.

all the tillable soils of the county. Some farmers who cultivate large areas of bottom land sell corn, but very little is shipped out of the county, and much is shipped in for feeding purposes each year. The light-gray upland and terrace soils and the sandy undulating and hilly types are not so well suited to the production of this cereal as the darker soils, but they produce fair yields under proper farming methods. The leading variety of corn on the upland is Reids Yellow Dent. In the bottom lands Boone County White and Johnson County White are grown to a greater extent.

In 1909 there were 49,965 acres sown to wheat, which produced 856,598 bushels, an average of over 17 bushels per acre. The area in wheat during the last few years has averaged about two-thirds that in corn. The soils best adapted to wheat are the loess soils in the eastern part of the county and the reddish-brown soils of limestone origin. Large areas of heavy clay soils in the Mississippi bottoms and considerable areas of gray terrace soils in the smaller stream valleys are used principally for this grain. The upland prairies were for a long time supposed to be of little value for wheat, but during the last 15 or 20 years they have been used quite extensively for this crop. By using commercial fertilizers, yields practically as large as those obtained on the hill and bottom land soils are produced. Although the average yield of wheat for the county is not high, acreage yields of 25 to 35 bushels or more on the better soils are common, and many farmers report an average of 20 bushels or more for a period of several years.

Next to corn and wheat, clover is the most important crop. It is of great value as a hay and pasture crop, but its use in building up the soils is probably of even greater importance. Clover is the only legume crop universally grown. Red clover is extensively grown on the well-drained limestone and hill soils and on the better-drained bottom lands, and the seed is a money crop in parts of the county. Where the drainage is not so good, on either the bottom lands or the upland, alsike clover is grown to some extent. Clover yields 1 to 2½ tons per acre annually, depending on the season. In favorable years two cuttings are obtained. When the crop is thrashed for seed from 1½ to 3 or 4 bushels per acre is obtained. White clover grows luxuriantly in the blue-grass pastures and affords much pasturage. Lespedeza during the last few years has gained a foothold in this region.

Other hay and pasture grasses of importance are timothy and redtop. These are especially suited to the level uplands and to the gray soils of the second bottoms. Millet is grown to some extent. Cowpeas and soy beans are receiving some attention. Cowpeas are usually sown immediately after wheat has been harvested, the seed being sown broadcast or drilled. The crop is also grown to some extent in corn fields, being seeded at the last cultivation.

Some attention has been given to alfalfa in the last few years. A deep, well-drained soil, such as is necessary for the best development of red clover, is required for alfalfa. Owing to its deeper rooting habits and longer life it is even more exacting than clover in this respect. Experiments made in many places indicate that on a level soil with a heavy subsoil layer like that on the upland prairies or on the second bottoms there is slight chance for success. The soils in Lincoln County best suited to alfalfa are the deep, well-drained bottom soils and the better grade of hill soils.[1]

Before the Civil War tobacco was produced quite extensively in Lincoln County. At present it is only grown on a small acreage for home use, although soils well suited to this crop are of considerable extent.

Apples are grown on a commercial scale by only a few farmers, although on the same grade of soil on the Illinois side of the river there are numerous large commercial apple orchards.

Topography, in so far as it influences soil development, has had some influence on the local agriculture. Areas which have remained level sufficiently long for the development of a gray layer and a heavy lower subsoil are not suited for clover because of their poor drainage and a tendency to be sour. Steep hill slopes also are usually not productive because the surface soils have been removed, leaving exposed heavy, leached subsoils or stony clays.

A few farmers are guided by natural adaptations in choosing fields on the various soil types for the different crops. The loess and limestone hill soils of the eastern part of the county are commonly recognized as the best upland types for wheat and clover. The recently deposited bottom-land soils are recognized as more productive than those which consist of old sediments. The limestone hill soils are recognized by cattle men as being better grass soils, supporting a better fat-producing grass than either the bottom land or the level upland soils. The heavy clay soils of the Mississippi bottom are commonly recognized as better suited for wheat than for corn. Oats are grown much more extensively on the level uplands than in the hilly region.

Land to be sown to wheat is plowed by the better farmers as early as possible in the late summer or early fall, and carefully worked into a mulch to conserve soil moisture. At seeding time, about October 1 to 10, it is disked and harrowed until the subsoil is well compacted. Fertilizer is applied with the drill at the time of seeding. When wheat is to follow corn the latter is shocked or put into the silo and the ground is prepared by disking without breaking. When wheat

[1] "Alfalfa on Missouri Farms," a bulletin published by the Missouri State Board of Agriculture, gives valuable information concerning the growing of this crop.

land is to be seeded to clover the clover is sown in the spring as soon as danger from freezing has passed, and left without cultivation. Wheat is cut with self-binders and usually thrashed from the shock.

Land to be planted in corn is plowed either in the fall and left rough until spring or plowed in the spring. It is put in good tilth by the use of disk and other harrows and planted at any time between April 15 and June 15, about May 1 being considered the most favorable time. Corn is either checked or drilled. The crop receives 3 to 6 cultivations. A large acreage of corn is cut for filling silos.

The average farm in Lincoln County has a large well-built farmhouse, one or more large, well-painted barns, and one or more silos, and is well equipped with modern farm machinery. This usually consists of a binder, one or more mowing machines, a manure spreader, wagons, plows, and harrows of various kinds. A farm tractor, an automobile, and a gas engine are often part of the equipment.

On the better upland soils corn is grown for 1 or 2 years and followed by wheat. Clover is sown on wheat land in the spring and either cut for hay in the fall, after the wheat has been removed, or used for pasture. The third year the clover is cut, making two crops if the season is favorable. The land is then put back into corn, thus making a 3 or 4 year rotation. Frequently corn is followed by oats, and this crop by wheat and clover. Another variation consists in following wheat with timothy and redtop. These grasses are usually mixed with some clover, and the crop is used for pasture for two or more years. On the bottom lands subject to frequent overflow corn is often grown continuously for a number of years, and some farmers grow wheat on the same land for several years in succession. The soil in this case is kept in a high state of productiveness by seeding thinly to clover each spring, and plowing under the clover in the fall.

Manure is usually applied, as it accumulates, to fields intended for corn. Fertilizers are used to a considerable extent on wheat and to some extent on corn. In 1909 a total of $48,977 was expended in Lincoln County for fertilizer on 1,097 farms, an average of $44.65 each. Owing to the increased use of fertilizers and to the higher prices, the amount expended at present is very much more than this. Although lime is needed on nearly all the soils of the county and is to be had at about $1 a ton, very little has been used to the present time.

The farm laborers in this county are mainly native white persons, although considerable negro labor is employed. Laborers hired by the season receive $25 to $40 a month and board. Hired hands with a family are furnished a house and garden and often permitted to

keep a cow and chickens. Pre-war prices for day labor ranged from $1.50 to $2 a day.[1]

Farms in this county range in size from 80 acres to a few hundred acres. There are not many very small farms, and only a few in excess of 500 acres. The average size in 1910 was 133 acres. In that year 74 per cent of the farms were operated by owners. Most of the upland farms are rented for cash, the rent depending upon the location, improvements, and other factors. The greater part of the cultivated bottom land is rented on shares, one half the corn or wheat, delivered, generally being given the land owner. Some owners, however, receive only two-fifths the crop.

Land prices have a rather wide range. The best grade of alluvial land in the Mississippi bottoms is held at about $150 an acre. The heavy clay land and the gray land with light-gray subsoil range in price from $60 to $100 an acre. These prices also cover the valley lands of Cuivre River and the smaller streams. The better grade of prairie land ranges in price from $65 to $75 an acre, and the best grade of hill land from $70 to $100. The poorer hill land, much of which is rough and broken, can be bought at $25 to $40 an acre.

SOILS.[2]

The soils of Lincoln County may be divided into two broad classes, viz., upland soils, derived from glacial till, the underlying rock beds, and loess or windblown material; and bottom-land or alluvial soils, consisting of sediments deposited by streams on their present or former flood plains, the latter now constituting terraces.

Glacial till is the most important source of the upland types, soils of this description covering more than two-thirds of the county.

[1] In 1920, however, day labor was paid from $3.50 to $4 a day.

[2] Pike County was mapped in 1912, Lincoln in 1917. In the interval between these dates considerable advancement was made both in the refinement of soil differentiation due to a broader knowledge of soils gained through studies made over wider and wider areas of country and in the refinement of detail in the placing of soil boundaries on the map. The soil maps are progressively more accurate as maps and the soil definitions recognize a constantly increasing number of characteristics as criteria worthy of utilization in the definition of soil units. The above changes cause the Lincoln County soil map to fail to fit the adjoining part of the Pike County map exactly. The soil mapped Shelby loam in southern Pike County adjoins the Lindley silt loam in Lincoln County. In Pike County it was recognized as a silty loam but was thought to be a little nearer a loam than a silt loam. In Lincoln a more mature judgment placed it in the silt loam class. It is a true silt loam but a little coarser than typical and in practice acts as a heavy loam or light silt loam. In Pike County the Shelby soils included both light and dark colored soils derived from glacial drift. By the time Lincoln was mapped, it was agreed by the Bureau and State Soil Surveys that the light colored Shelby should be separated from the dark colored and it was further agreed that the term "Shelby" should be held to the dark-colored soil and the name "Lindley" be applied to the corresponding light-colored soil.

Rough stony land in Pike County joins Hagerstown stony loam in Lincoln County. This is due to a recognition that the land is better than Rough stony land, so it was grouped with the stony loams.

The soil mapped Knox in Pike County has been subdivided since 1912 into the Memphis, Clinton, and certain silty members of the Hagerstown series. The Knox series is

During glacial times one or more of the vast ice sheets extending as far south as the Missouri and Ohio Rivers covered this territory, bringing not only foreign material carried from long distances, but also much material scoured from the near-by rock beds. Pebbles and bowlders of quartz and granite, smooth and waterworn, and small sharp fragments of flint were embedded in masses of clay and silt. In many places soft rock beds of limestone, sandstone, and shale were ground into powder and formed a very large part of the till. In Lincoln County, which lies near the southern limit of the glaciated area of North America, probably more than 95 per cent of the till is of local origin.

There are considerable areas of residual soil in Lincoln County, derived from the weathering of the underlying rocks through long periods of time. The residual soils are found both where no glacial material was deposited and where it has been removed by erosion. The underlying rock formations consist of alternating beds of limestone, sandstone, and shale. Some of the limestone beds are thick or massive, while others are thin and have between them thinner beds of chert or flint. Loessial or windblown soils have been formed in many places on the upland adjacent to the Mississippi River.

The various soil materials, namely, glacial till, rock residuum, and loess, have undergone certain changes by which they have been converted into soils as they exist at present. Some of the more obvious of these changes are due to erosion, to weathering, to drainage, and to the influence of plant growth. The soils as a whole are light in color, being light yellow, light brown, or light gray. They are uniformly silty in texture at the surface and have a heavy subsoil.

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now held to soils that are brown in color with a calcareous deep subsoil and neither compaction nor increase in heaviness of texture from soil to subsoil. These conditions do not exist in Lincoln County. The name Marshall is now confined to soils that are very dark brown in color and without compaction or increase in heaviness of texture in the subsoil and with a highly calcareous subsoil or substratum. These conditions do not apply to the soils mapped Marshall in Pike County. They fit the characteristics of the Memphis soils.

The Lintonia silt loam in Pike County joins up with the Genesee silt loam in Lincoln County. The difference here is theoretical rather than practical, so that for practical purposes these two soils are identical and either term may be used, though it should be mentioned that the Lintonia definition is now in process of change and in the future it will not have the same meaning even practically as Genesee.

An extension of an area mapped Wabash silty clay loam, poorly drained phase in Pike County, was mapped, as phases of the Lintonia and Genesee silt loams. This change was made because of the light color of the soil, the Wabash now being held to dark-colored alluvial soils.

Certain minor discrepancies are found with respect to the Wabash soils along the boundary near the Mississippi. This is due entirely to more careful mapping in Lincoln County and the results in that county should be considered as final. The adjoining Wabash silty clay loam, poorly drained phase, in Pike County is now known to be really a clay loam, though the difference between clay loam and silty clay loam is too slight to be of any essential value in general agriculture, and it is further known that the Pike County area is not poorly drained. It was subject to flooding by the river before levees were built, but the soil is not otherwise wet.

The lower subsoil is a mottled gray, brown, and yellow clay containing more or less material of foreign origin.

The upland soils of Lincoln County may be broadly divided into five classes: Soils of the nearly level uplands having a heavy subsoil; brown soils occupying gentle slopes and ridges; yellow and light-gray, shallow soils of the steeper slopes; light-brown to reddish-brown soils extending along the river side of the uplands; and rough, stony areas where the underlying rock beds are exposed.

The nearly level uplands include two soils, the Putnam silt loam, a dark-gray prairie type, and the Marion silt loam, a light-gray forested type. The brown soils occupying the gentle slopes and ridges consist of three types, viz, the Putnam silt loam, rolling phase, which is transitional between the typical Putnam of the level uplands and the Lindley of the gentle slopes, the Lindley loam, and the Lindley silt loam. The yellow and light-gray, shallow soils of the steeper slopes are mapped as the eroded phase of the Lindley silt loam and the Clinton silt loam. The light-brown and reddish-brown soils are correlated as Memphis silt loam and Hagerstown silt loam and stony loam. Rough stony land a nonagricultural type in this area really consists of Hagerstown material. One other series of upland soils, the Leslie, was identified in the county. It is inextensive, and represented by one type, the clay loam.

The bottom-land soils of Lincoln County may be divided into two classes; first-bottom soils, which include the main body of the larger valleys, and terrace or second-bottom soils. The first-bottom soils which are of more recent origin, consist of sediments deposited in their present flood plains by the Mississippi River and its tributaries. Terrace soils are found on the higher bottoms or on remnants of much older flood plains in the valleys of both the Mississippi River and the smaller streams. These older alluvial soils, like the level upland soils, have undergone important changes since their deposition. The younger or more recently deposited soils show little change, while the older of the first-bottom soils show some evidence of aging—indicated by the possession of a gray layer in the upper subsoil. The terrace soils show the greatest change, as they have a heavy-clay lower subsoil and upper gray layer as completely developed as in the more level parts of the uplands. The alluvial soils range in texture from fine sandy loam to clay, the difference being due to the assortment of soil particles while in suspension, the coarser particles having been deposited by swiftly moving water, and the finer by water moving slowly or standing.

The dark-colored first-bottom soils are correlated as Wabash silt loam, silty clay loam, clay loam, and clay. The gray first-bottom soils are classed as Waverly silt loam. The light-brown first-bottom soils belong to the Genesee series, of which the fine sandy loam and

silt loam are mapped. On the terraces the gray soils are classed as the Calhoun silt loam, and the brown soils as the Buckner loam. The Lintonia silt loam includes areas of brown soils deposited as deltas or outwash material by streams entering the larger valleys.

In the following pages of this report the various soils of Lincoln County are described in detail and their relation to agriculture discussed. Their distribution is shown on the accompanying map. The table below gives the actual and relative extent of each type mapped:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Lindley silt loam	49,344	24.2	Rough stony land	9,536	2.5
Eroded phase	44,608		Calhoun silt loam	7,808	2.0
Putnam silt loam	19,264	15.7	Wabash silt loam	6,720	1.7
Rolling phase	41,536		Wabash clay loam	4,800	1.2
Genesee silt loam	38,208	11.4	Marion silt loam	3,584	0.9
Gray subsoil phase	5,952		Waverly silt loam	3,520	0.9
Hagerstown silt loam	38,144	9.8	Lintonia silt loam	2,432	0.7
Hagerstown stony loam	24,256	6.2	Shallow phase	512	
Clinton silt loam	22,912	5.9	Genesee fine sandy loam	2,240	0.6
Lindley loam	20,864	5.4	Buckner loam	448	0.1
Memphis silt loam	20,608	5.3	Leslie clay loam	320	0.1
Wabash silty clay loam	11,200	2.9			
Wabash clay	9,664	2.5	Total	388,480	

PUTNAM SILT LOAM.

The surface soil of the Putnam silt loam is a gray or brownish-gray silt loam which appears dark gray, dark brown, or almost black when moist. Color and texture remain fairly uniform to a depth of 8 or 10 inches, or about the maximum depth of cultivation. Here faint gray mottlings appear, becoming more pronounced with depth. The material below 10 or 12 inches is a very light gray silt loam, loose and flourlike when dry, but rather plastic and sticky when moist. This layer frequently carries, especially in the lower part, small iron concretions. At 15 to 18 inches, or occasionally at slightly greater depths, this light-gray layer is underlain very abruptly by a darker colored stratum, usually dark gray, dark brown, or reddish brown, and 8 to 12 inches thick. In the lower part this is distinctly mottled with light brown, reddish brown, gray, and yellow. In texture it is a heavy, tenacious, impervious clay, which upon drying cracks and breaks, like adobe or gumbo soil, into cubical masses. Below the heavy layer mottlings of gray and yellowish brown become more pronounced and the texture becomes much more silty and more friable. In places the lower subsoil contains much light-gray sandy clay.

These four layers—the dark-gray surface soil, light-gray subsurface layer, heavy-clay upper subsoil, and lighter-textured lower subsoil—although differing in thickness, are always found in this type in the order given. In road cuts or along gullies they give the walls a banded appearance, owing to their difference in color and structure. The heavy layer of this type is called a hardpan or claypan, but it is not a true hardpan, since the soil particles are not cemented into a compact mass, but are held closely together principally on account of their fineness of texture. It nevertheless affects the internal drainage and aeration of the type. It has been formed through the carrying down of soil particles by percolating soil water to this zone of concentration. After its formation underdrainage and thorough aeration have become restricted, oxidation in the overlying soil has been checked, and the gray layer formed. This subsoil condition, although most extensively developed in this region in the Putnam silt loam, is not confined to this type, but occurs wherever a silty or clayey soil remains level long enough for the claypan development.

The Putnam silt loam is subject to considerable variation. Its naturally dark color at the surface is due largely to organic matter from decaying prairie grasses, and where there was originally some forest growth the soil is lighter gray or light brown. The depth of the dark surface soil, the thickness of the gray layer, and the color of the heavy layer also are subject to considerable variation.

The principal areas of Putnam silt loam occur on the ridge between Troy and Hawk Point, south and southwest of Hawk Point, north and east of Olney, west and northwest of Millwood, east of Whiteside, and north of Harmony Grove Church. Smaller areas are mapped throughout the central and western parts of the county. This soil at one time doubtless had a much greater extent than at present, a large area having gradually been changed by erosion to the rolling phase or to the Lindley soils.

The topography ranges from smooth and almost level to gently rolling, the greater part of the type having the latter topography. Surface drainage is good, except in the more nearly level areas, but underdrainage is deficient on account of the heavy clay layer. This also prevents the rise of soil moisture from lower depths, so that crops suffer not only from excessive rainfall but also during prolonged dry periods.

This is one of the most important soils in the county. It is practically all under cultivation, and returns are usually good. The principal crops are corn, oats, timothy, bluegrass for pasture, wheat, redtop, and clover. Minor crops are sorghum, millet, rye, cowpeas, soy beans, and orchard fruits. Practically all the crops are consumed on the farm and marketed in the form of finished products. Cattle,

hogs, and mules are fed in large numbers. Some young stock is raised, but most feeders now go to the Kansas City or St. Louis markets for cattle and to a less extent for hogs. Dairying is carried on to an increasing extent.

Yields in good seasons where the type is well handled are: Corn, 35 to 40 bushels per acre; wheat, following a small-grain crop, 15 to 18 bushels; and oats, 30 to 50 bushels.

This soil is usually farmed in large rectangular or square fields suitable for the use of heavy farm equipment, including tractors. Nearly all wheat fields receive 100 to 150 pounds per acre of a fertilizer high in phosphates, which is also beneficial to the clover or timothy following. Fertilizers are also being used to an increasing extent on corn and oats. Ground limestone is applied to some extent. Nearly all the land of this type is well improved, and it sells for $60 to $100 an acre.

The productiveness of much of the Putnam silt loam has been impaired by continuous cropping with corn, and it needs more organic matter and nitrogen. On many farms it has been improved by putting the land in pasture, applying manure, plowing under all available straw, trash, and stalks; and by growing clover, cowpeas, and soy beans as extensively as possible. Where the soil is too wet or sour for red clover, alsike can frequently be grown. A systematic crop rotation should be followed in which corn should not be grown more than two years in succession. Thorough surface drainage by open ditches will prove beneficial, and experiments carried on at Vandalia, in Audrain County, seem to indicate that where an outlet can be obtained without too great expense this soil may profitably be tile drained.

Experiments carried on by the Missouri Agricultural Experiment Station on soil of this type near Bowling Green, in Pike County; near Monroe City, in Monroe County; and at High Hill, in Montgomery County,[1] show that a rotation consisting of corn for two years, followed by oats, this by wheat, and the wheat by timothy and alsike clover for two years, should be adopted as nearly as practicable. The soil should be gradually deepened by plowing one-half inch to 1 inch deeper each time until a depth of 9 or 10 inches is reached. Fields should be disked before plowing, particularly stalk and stubble fields. Thorough, shallow cultivation for corn is recommended. The experiments show that on this soil a ton of manure has a value ranging from $1.60 to $2.25 in increased yields. Lime is needed in greater or less degree, but is not necessary as a fertilizer, except when red clover is to be grown. It should be looked upon as one of the cheaper means of improving general pro-

[1] Bulletin 126, Missouri Agr. Expt. Sta.

ductiveness of the soil by putting it in better condition for bacterial growth. Experiments show that a fertilizer high in available phosphorus, such as acid phosphate or bone meal, can be applied with good profit, while a small amount of potassium will usually be profitable. Bone meal containing 1 to 2 per cent of nitrogen and 26 to 28 per cent phosphoric acid, applied at the rate of 100 to 200 pounds per acre before wheat, gives good results. For corn, on areas of declining productiveness, this can well be applied at the rate of 150 to 225 pounds per acre. Acid phosphate, which is much cheaper, is also recommended, to be applied at the rate of 125 to 200 pounds per acre before wheat and 175 to 250 pounds before corn. These phosphates are especially effective on grass and clover when these are seeded alone or with wheat. The use of raw rock phosphate has not proved as profitable as bone meal. Fertilization alone, without crop rotation, manuring, and other means of keeping up the supply of organic matter, is not advisable.

Putnam silt loam, rolling phase.—The rolling phase of the Putnam silt loam consists of a light-brown or grayish-brown silt loam which becomes slightly heavier with depth. At 8 or 10 inches faint mottlings of gray appear, and they increase until the entire mass assumes an ashy-gray color and the same loose, flourlike structure found in the corresponding gray layer of the typical soil. In the phase, however, this layer is not quite so thick and in many places it is less gray than in the typical soil. At 12 to 16 inches the gray layer is underlain by a heavy, brown, or reddish-brown clay, mottled either with reddish or yellowish brown and gray in the lower part. This has a thickness of 6 to 10 inches and grades into a more distinctly mottled, lighter colored, and more silty, sandy clay subsoil.

This phase is subject to wide variation, ranging from the typical Putnam silt loam on the one hand to the Marion or Lindley silt loam on the other. It may be considered as transitional between the Putnam and the adjacent soils, to which it is gradually being changed through weathering. It occurs as a narrow rim surrounding the areas of typical Putnam silt loam; in long, narrow strips which extend out along all the drainage divides, whose more nearly level parts are occupied by the typical soil; and in numerous long, narrow strips along the crest of divides on which no areas of the typical soil remain. These last-named areas are found throughout all parts of the upland except near its eastern border.

Near areas of typical soil the phase differs little from it, but the difference increases as the outer edges of the phase are reached. Likewise, level areas within the phase approach more nearly the typical soil than do those of more rolling topography. In general, the areas in the western part of the county approach much nearer

the typical soil than do the smaller isolated areas in the eastern and central parts.

On account of its more rolling topography and slightly more permeable subsoil, both surface drainage and underdrainage are somewhat better in the rolling phase than in the typical Putnam silt loam. Practically all of the phase is under cultivation. It was originally forested to a considerable extent, and in some places the forest growth has encroached upon the prairies along this soil since the settlement of the county. The growth consists principally of hickory, black oak, laurel oak, elm, wild cherry, with some white oak.

The crops are very much the same as on the typical soil, but corn and oats are grown to a somewhat less extent and wheat and clover to a correspondingly greater extent. The same system of general farming and stock raising is followed. Yields do not vary materially from those on the typical soil. Land prices are probably as a whole slightly lower. The soil is handled in much the same way as the typical Putnam silt loam, and can be improved in productiveness by the same means.

MARION SILT LOAM.

The surface soil of the Marion silt loam is a light ashy gray or almost white silt loam. Under virgin conditions the surface 3 inches is very slightly darker, but after cultivation for a short time this is lost. When dry the soil has the loose, flourlike structure of the gray layer of the Putnam silt loam. At a depth of 12 to 15 inches the soil is underlain very abruptly by a drab or bluish-gray, heavy, tenacious, impervious clay, without mottling. This heavy subsoil continues to a depth of 26 to 30 inches, below which mottlings of yellowish brown and gray appear and the texture becomes more silty, this portion of the subsoil differing little from that of the Putnam silt loam. Scattered over the surface and through the gray layer are in many places numerous small iron concretions. In some places the gray surface soil has a slightly yellowish, creamy color and is slightly deeper than typical. Such spots are somewhat more productive.

The principal areas of Marion silt loam are found near Chantilly, north of Old Alexandria, and along the divide in the extreme southwestern part of the county. Numerous smaller areas form slight extensions from some of the upland divides or narrow, flat-topped ridges. In places where a level upland area extends almost to the bluffs adjacent to a large stream a narrow rim of this type occupies the outer edge of the upland. Numerous small areas of Marion silt loam, many of them too small to be shown on the map, occur in

the smooth, level regions, to which the type is confined. Although this soil frequently occurs on narrow ridges, it is not well drained, owing largely to the impervious subsoil.

The greater part of this type is under cultivation, but owing to its small extent and its low productiveness it is not important. Where it is forested the growth consists very largely of post oak, with some blackjack oak and in places small white oak. Corn is the principal crop, with wheat and clover of secondary importance. It yields 15 to 20 bushels per acre, and wheat 8 to 10 bushels. In other parts of Missouri this type is used to some extent for small fruits, with fairly good results. Alsike clover, cowpeas, and soy beans do well, and are the best legume crops for building up the soil.

Farms of which this type constitutes an important part range in price from $35 to $45 an acre.

LINDLEY LOAM.

The surface soil of the Lindley loam is a light-brown, yellowish-brown, or grayish-brown fine sandy loam to loam, which grades slightly heavier with depth. At 8 to 12 inches the color becomes slightly lighter and the texture ranges from a heavy loam to a clay loam or fine sandy clay. Mottlings of gray, brown, reddish brown, and yellow appear in this section of the subsoil, and increase in proportion with depth. Below 16 to 20 inches small, sharp fragments of chert and waterworn pebbles of foreign rock are present, and in many places they increase in abundance with depth. In other places the light sandy clay subsoil extends to a depth of 3 feet or more with the inclusion of small chert fragments or foreign material.

Considerable variations in color, texture, and crop value occur in this type. It ranges in color from light-yellowish brown or occasionally mottled gray and reddish brown on the steeper and more eroded slopes to dark brown where conditions have been favorable for the accumulation of organic matter. Both surface soil and subsoil vary according to the amount of sand or clay in the parent glacial material.

The principal areas of Lindley loam are found in the southwestern part of the county between the West Fork of Cuivre River and Big Creek, and near Millwood. The type occurs principally on long slopes between the Putnam silt loam or its rolling phase and the stream flood plain. In places it is irregular in occurrence, and numerous small bodies which can not be shown on the soil map are included with the Lindley silt loam. On the other hand, bodies of the silt loam are included with this type. The topography ranges from undulating to gently rolling. Surface drainage is good to excessive, and the underdrainage is adequate.

This is not as important a type as the Lindley silt loam. It is much less extensive, and the sandier areas are somewhat less productive. Practically all of the type was originally covered with a forest growth much the same as that on the silt loam, but nearly all of it has been brought under cultivation. The crops grown are principally corn, wheat, oats, and clover. The yields of corn and wheat are usually not quite so high as on the Lindley silt loam. Corn ranges from 30 to 35 bushels per acre. The same methods of handling are used as on the silt loam. Land of the two types is held at about the same price.

The following table gives the results of mechanical analyses of samples of the soil, subsurface soil, and subsoil of the Lindley loam:

Mechanical analyses of Lindley loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
344622	Soil	1.1	5.0	3.4	14.6	13.2	45.1	17.4
344623	Subsurface soil	1.4	3.8	2.5	11.5	12.5	42.0	26.2
344623a	Subsoil	1.3	3.0	2.3	10.0	9.5	37.9	35.9

LINDLEY SILT LOAM.

The soil of the Lindley silt loam is a light-brown, grayish-brown, or reddish-brown silt loam grading heavier with depth. At 10 to 16 inches this grades into a brown, heavy sandy clay which is usually more or less mottled with reddish brown, gray, or yellow. Below 26 to 30 inches the color becomes lighter and the structure more friable. Small fragments of chert and waterworn pebbles are frequently embedded in the clay of the lower subsoil.

This type has the widest variation of any in the county. Owing to its occurrence on hill slopes the surface soil has in many places been almost or entirely removed, leaving the heavy sandy clay layer near or exposed at the surface. In such places yields, especially in dry seasons, are low. A cross section where a strip of this soil extends along a small stream into the areas of Putnam soil would show typical gray silt loam on the upper slopes; the reddish-brown subsoil at or near the surface on the edge of the breaks, forming unproductive "scalds" or "clay spots"; and deep, dark-colored soil partly covered by wash below the eroded areas. Conditions of this kind are to be found throughout the region covered by this soil.

There also occur important variations depending upon the glacial material from which the soil has been derived. The greater part of the type, in some areas 95 per cent, is believed to be local material scoured from the underlying rock beds. Where this material consists

largely of shale the type closely resembles a residual shale soil. Where the till comes from massive bedded limestone it resembles a residual limestone soil, as in the vicinity of Moscow Mills, Troy, and Silex. Here the soil has a reddish-brown color and a somewhat granular structure, and is more productive than the average.

In almost level areas or on long gentle slopes there is frequently a heavy layer in the upper subsoil resembling rather closely the heavy subsoil layer of the Putnam series. Its process of development has doubtless been the same as that of the layer in the Putnam soils.

In Pike County, which adjoins this county on the north, extensive areas of this soil have been previously correlated with the Shelby series. On account of the darker color of these soils in the northwestern part of the State and in States farther west it is thought best to correlate them in Lincoln County with the Lindley series, which embraces lighter colored types.

The Lindley silt loam has the widest distribution of any type in the area. It occurs in nearly all parts of the upland. There are no very large continuous bodies, but south and east from Troy and in the northwestern part of the county it predominates over a considerable area. Between Troy and Silex it is an important type. It occurs on slopes and where the crests of the ridges are not occupied by Putnam soils occupies the entire ridge. The topography ranges from nearly level to undulating or rolling. Surface drainage is good and in places excessive, and the underdrainage, on account of the more sandy nature of the subsoil, is distinctly better than in the Marion or Putnam soils.

This is one of the most important soils of the county, on account of its wide extent and productiveness, and nearly all of it is under cultivation. It was formerly heavily forested, the growth varying from laurel oak, black oak, and hickory on the outer edges of the area, bordering the Putnam soils, to white oak, red oak, and in places blackjack oak near areas of the Hagerstown stony loam. Where the soil approaches the Hagerstown silt loam, walnut and large elm and pawpaw are common.

This type is used extensively for the production of wheat, corn, oats, timothy, and all the other common crops. Stock raising and feeding and dairying are carried on extensively. Wheat ordinarily yields 16 to 18 bushels per acre, corn 30 to 40 bushels, and oats 25 to 35 bushels. The type is handled in much the same way as the Putnam silt loam, large teams and heavy equipment being used.

Fertilizer is used extensively for wheat. From 100 to 150 pounds per acre of a complete fertilizer containing 1.5 to 2.5 per cent nitrogen, 8 to 12 per cent available phosphoric acid, and 2 to 3 per cent potash has produced good results on land that has run down. On areas fairly well supplied with organic matter 125 to 150 pounds of

raw bone or steamed bonemeal per acre has been used most effectively. For corn, on medium-poor lands, 60 to 75 pounds per acre of the same grade of fertilizer as that used on wheat, applied in the hill or drill with a fertilizer attachment, has given good results. Clover does well and is almost universally grown for keeping up the nitrogen supply of the soil.

Well-located farms on which this is the principal type sell for $75 to $100 an acre where the soil is in a good state of tilth. Areas where the soil has declined in productiveness, and poorly improved and unfavorably located areas can be had for $50 to $60 an acre.

Owing to its rolling topography this soil washes badly, and one of its principal needs is the prevention of erosion. This can be done by gradually deepening the plowing, which checks the rapid run-off and increases the capacity of the soil for holding moisture. Contour cultivation, and in some cases low terracing, would prove beneficial. The growing of winter cover crops of rye or wheat on the more easily eroded areas would prove helpful in checking erosion. Although much of this type is largely of limestone origin the greater part of the lime has been leached out, and where legume crops are to be grown ground limestone will often improve the catch and yield. The type has in many places suffered from excessive cropping to corn, which has reduced the supply of nitrogen and organic matter. A rotation should be adopted in which corn would not be planted more than two years in succession, and on the badly worn areas corn should be grown only one year. Clover, cowpeas, and soy beans should be grown as much as possible.

Experiments[1] have been carried on for some time by the Missouri Agricultural Experiment Station on a glacial soil somewhat similar to this in Linn County, Mo. Recommendations made as a result of these experiments are, in a general way, applicable to the Lindley soils of Lincoln County.

Lindley silt loam, eroded phase.—The Lindley silt loam, eroded phase, is light gray, yellowish gray, or light yellowish brown at the surface, but changes at 3 or 4 inches to more pronounced yellowish brown. The texture becomes heavier with depth, and at 8 to 12 inches the material is a light-brown or yellowish-brown clay, heavy and tenacious. There is, however, no sharp line of separation between this and the overlying soil. The color is fairly uniform to a depth of 18 to 24 inches, but the texture becomes somewhat heavier with depth. Where exposed and dried, as along roadside cuts, the subsoil material shows a somewhat cubical structure. Below this heavy layer, mottlings of light gray, brown, and dark brown appear, the proportion becoming greater with depth. The lower subsoil also

[1] See Bul. No. 128, Mo. Agr. Expt. Sta.

becomes somewhat lighter in texture and more friable, and over much of the area includes fragments of chert and some foreign material embedded in the clay. In many places, especially on the lower slopes, the glacial soil has a depth of less than 3 feet and rests upon cherty residual soil.

The phase as a whole is subject to considerable variation. On the upper slopes and especially on level or almost level areas the surface material is frequently light gray and the subsoil is heavier and more tenacious than typical. On the steeper slopes the soil in places is much lighter in texture, resembling the Lindley loam and in other places the reddish-brown Hagerstown silt loam. As a whole the phase is lighter colored at the surface and more deficient in organic matter than the typical Lindley silt loam. The subsoil is slightly heavier and lies nearer the surface.

The eroded phase of the Lindley silt loam has a wide distribution throughout the uplands adjacent to Big Creek Valley in the southern part of the county, along both forks of Cuivre River, Sugar Creek, and the other principal streams of the county. It usually occurs on hill slopes and low eroded divides. On the lower slope it sometimes extends to the adjacent flood plain, but is usually separated by a belt of Hagerstown stony loam. The topography ranges from undulating or rolling to broken. In places the slope is too steep for profitable cultivation. Surface drainage is good to excessive, but the underdrainage, on account of the heavy clay subsoil, is not thorough.

This is not so important a soil as the typical Lindley silt loam, although approximately 75 per cent of it is under cultivation. The remainder is forested, principally with white oak, post oak, and black oak and some blackjack oak. On areas bordering on the Marion silt loam post oak predominates. Wheat, clover, bluegrass for pasture, and corn are the most important crops. In the vicinity of Winfield the phase is used rather extensively for dairying. Wheat yields 10 to 15 bushels, corn 15 to 25 bushels, and oats 20 to 30 bushels per acre. Owing to its somewhat broken character, lighter farm equipment is used on this soil than on the more nearly level types. About the same grade and amounts of fertilizers are used. Land values range from $35 to $50 an acre.

The greatest needs of this soil are an increase in the organic supply and the prevention of erosion. Much of it on account of steepness of slope should be kept in permanent bluegrass pasture, for which it is well suited. Old fields practically abandoned can best be brought into a state of productiveness by sowing to rye or wheat, which should be plowed under and followed by cowpeas or soy beans and this by clover. One or more crops of clover plowed under will rapidly bring the soil into a much more productive state. When forested

areas occupy steep slopes these should be put into pasture directly without being used for cultivated crops. This can best be done by cutting the trees at a height of about three feet from the ground and pasturing closely with goats for two or three years. Seeding to bluegrass is not necessary, but will insure a better and quicker stand of grass. Much of this soil now in forest or practically abandoned to briers and underbrush could be put into pasture profitably.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the typical Lindley silt loam:

Mechanical analyses of Lindley silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
344661	Soil	0.6	1.1	0.9	3.9	6.9	67.9	18.6
344662	Subsoil	.3	2.7	2.0	8.4	9.5	51.3	25.9

CLINTON SILT LOAM.

The Clinton silt loam is a light yellowish brown, smooth, uniform silt loam to a depth of 12 to 16 inches. This grades into a similarly colored heavy silt loam or clay loam, possibly a little heavier than the heavy layer of the Memphis silt loam, which continues to a depth of 3 feet or more with little change in color or texture.

Areas in which the surface soil assumes a light-gray color are much more extensive than in the Memphis silt loam, and slight mottlings in both soil and subsoil occur much more frequently. The principal difference from the Memphis, however, is in the somewhat lighter colored surface soil and the heavy subsoil, which does not grade into a lighter subsoil below. The Clinton is intermediate between the typical Memphis on the one hand and the Lindley and Marion silt loams on the other. In some places it is underlain by residual soil and in others by glacial drift.

The Clinton silt loam extends westward from the belt of typical Memphis soils, and only a few isolated areas lie more than 10 miles from the eastern edge of the upland. In general the type occupies small low ridges and upper slopes, the lower part of which is occupied by the Hagerstown silt loam or stony loam. The topography in general is less rolling than that of the Memphis silt loam.

Practically all this soil is under cultivation. It was originally forested principally with white oak. The type is handled in the same way and devoted to the same crops as the Memphis silt loam, but the yields are not quite as high. Land values are somewhat lower.

The following table gives the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Clinton silt loam:

Mechanical analyses of Clinton silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
344627	Soil	0.0	0.2	0.1	4.6	4.6	68.6	25.5
344628	Subsoil	.0	.1	.1	.8	4.6	68.6	25.5
344629	Lower subsoil	.0	.1	.1	.5	6.2	66.8	26.2

MEMPHIS SILT LOAM.

The Memphis silt loam is a very light brown or slightly yellowish brown, light, smooth silt loam grading at 12 to 16 inches into a similarly colored, somewhat heavier silt loam to clay loam, which at 24 to 28 inches gives way to a silt loam of slightly lighter texture. In fields where the soil is in a good state of tilth the surface 6 to 8 inches is slightly darker brown than the underlying soil, which remains almost uniform in color to a depth of 3 feet or more. The structure of the heavy subsoil layer where well developed resembles rather closely that of the corresponding layer in the Lindley silt loam. In the subsoil, along planes of fracture, very thin gray layers are often encountered. Where exposed to the direct action of running water this soil erodes badly, but where it is cut into, as along roads or gully banks, it stands as almost perpendicular bluffs for a long time.

The Memphis silt loam as mapped shows considerable variation. It is deepest and most typical in the eastern area of its occurrence. Toward the west the depth to underlying deposits of different origin becomes less and the soil grades heavier in texture. In a few places near the eastern boundary of the type layers of very fine sand are found in the subsoil. In level or nearly level areas, as on ridges and benches on the slopes, and on long gentle slopes, the surface soil has become light ashy gray and the subsoil is rather distinctly mottled with dark brown. Such areas are less productive than the typical soil. In other places on long slopes deficient underdrainage has resulted in a gray mottled subsoil even where the surface soil is typical. As mapped this type includes some perpendicular rock ledges and narrow, steep slopes on which rock outcrop occurs, these being too narrow to show on the map as Rough stony land.

The rolling or undulating character of the country covered by this type is well brought out in Plate I, which shows the upland as it appears to the west from a point near Elsberry.

The Memphis silt loam extends in a narrow belt along the hilly region in the eastern part of the county, reaching to the bluff which borders the Mississippi flood plain. Its western edge is much more irregular, extending out into the broad basins drained by Bryants Creek and Lost Creek but receding around the high hills west of Apex. In the northeastern part of the county the belt has an approximate width of 5 miles, but 3 miles south of Elsberry it narrows to little more than 2 miles and continues at about this width almost to Old Monroe.

The greater part of the type is rolling to moderately hilly. Some of it is broken. Surface drainage is good and often excessive, and the underdrainage where the soil is of sufficient depth is also good. The soil takes up moisture well and is the most retentive of the upland types. Except in the steepest areas and in a few places where rock ledges outcrop it is practically all under cultivation, the native heavy forest of large white oak, elm, walnut, hard maple, and paw-paw bushes having been removed. The type is not only productive, but it is suited to a wide range of crops, and is durable and easily cultivated. It is the best upland wheat and clover soil in the county. Wheat yields 15 to 30 bushels per acre, and corn 40 to 50 bushels. There are only a few commercial orchards, but the type is well suited to orchard fruits and small fruits, and in Calhoun County, Ill., across the Mississippi River, there are numerous large and profitable apple orchards on soil of this type. Alfalfa is grown to some extent and each season three cuttings of one-half ton to over 1 ton each are obtained. Tobacco is a crop of little importance in this county, although it is produced quite extensively on this soil in other parts of the State. Near St. Louis this type is used extensively for gardening. Fertilizers at first were not employed for either wheat or corn, but much of the type has been impaired by continuous cropping to wheat, and in recent years crop rotations have been adopted and commercial fertilizers used to an increasing extent.

Land of this type, well situated and well improved, varies in price from $80 to $120 an acre. In the more hilly sections prices range from $60 to $75 an acre.

This soil, although quite productive, needs an increase in the supply of organic matter and nitrogen. A deeper moisture-holding layer could be made available by means of deeper plowing and the adoption of more effective methods to prevent erosion. This soil could well be used to a much greater extent for apple orchards, for small fruits of all kinds, for melons and other garden truck, and for alfalfa.

HAGERSTOWN STONY LOAM.

The Hagerstown stony loam consists of a gray, yellowish-gray, or reddish-gray stony silt loam grading at 8 to 12 inches into a subsoil of reddish-brown or dull-red stony clay loam or clay. The color becomes deeper red with depth, and the texture usually heavier. Throughout the greater part of the type the stone content ranges from 25 to over 75 per cent of the soil mass. These coarse rock fragments, mostly chert, range from one-fourth inch to several inches in diameter. Some of them are white and sharp, but many of them are soft, reddish brown in color, and partly decomposed. There are also places in which limestone ledges outcrop, and others in which limestone fragments are found on the surface and in the soil and subsoil. On some steep slopes, where erosion has been rapid, beds of shale are exposed, and some areas largely of shale origin are included. Over much of the type the parent bedrock is reached at depths ranging from a few inches to 2 feet.

The surface ranges from very rolling to broken, and the slopes over much of the type are too steep for profitable cultivation, even where not too stony.

The Hagerstown stony loam occupies the greater part of the steeper slopes adjacent to the stream valleys in all sections of the county. With the exception of small areas in which the percentage of stone is less than typical, it is uncultivated. The greater part of it is covered with small trees and underbrush, the merchantable timber having been removed. A considerable acreage has been cleared and is used for pasture, as a good growth of bluegrass and white clover springs up which is said by stockmen to be superior in quality to that on the more nearly level upland soils.

Farms on which the Hagerstown stony loam is the predominant type range in price from about $20 to $40 an acre.

Large areas of this type that are almost nonproductive might at very slight expense be made into excellent pasture lands. In the Ozark region on soil of this character orchard grass has been found well suited for pasturage. The less stony areas have been found well suited for the production of strawberries and grapes.

HAGERSTOWN SILT LOAM.

The surface soil of Hagerstown silt loam consists of a light-brown to reddish-brown, rather granular silt loam which becomes slightly deeper red and heavier in texture with depth. At 12 to 15 inches it grades into a distinctly reddish brown, granular clay loam to clay subsoil, slightly mottled with gray and dark brown in some areas. Below 18 to 24 inches the material becomes deeper reddish brown and more friable. This sort of material may continue to a depth of 3 feet, but is in many places underlain at a less depth by the parent limestone. In the lower part of the 3-foot section and to some extent

in the surface soil there are fragments of chert and limestone. The type has a wide variation. In many places it is more or less mixed with the adjacent glacial soils on one side and thins out on the other along rock ledges or outcrops.

In several places small areas in which a light-brown, hard, thin-bedded shale locally known as "gingerbread rock" comes near the surface have been included with this type. In such the soil has a yellowish color, is less granular, and heavier in texture than the typical Hagerstown silt loam. It is also less productive. These areas occur immediately north of Newhope, southeast of Reids School, and in several other places. They are readily recognized by thin layers of shale exposed along the roadside or by the hard shale fragments scattered through the surface soil.

The principal developments of Hagerstown silt loam occur along the slopes bordering the small stream valleys in the eastern part of the county, along the upper tributaries of Bryants Creek in the northern part, south of Auburn, and in the northwestern part of the county. It is developed in two principal topographic positions; in long, narrow strips on the lower hill slopes and in irregular upland areas, many of which contain sinks. Both the run-off and underdrainage are good.

The greater part of the Hagerstown silt loam is under cultivation. Some small isolated areas closely associated with the stony loam type or Rough stony land are unused. In the forested areas walnut, hard maple, large white oak, elm, and red oak make up the principal growth. The type is used for the same crops as the Memphis silt loam, and in the better areas the yields are approximately as good. Land values are about the same.

The Missouri Agricultural Experiment Station has for a number of years conducted field experiments on the red limestone soils of southwest Missouri,[1] and the results, on account of similarity in soil and climatic conditions, are believed to be applicable to the Hagerstown, Memphis, and Clinton silt loams of Lincoln County.

In these experiments phosphates have given the best results, potash next, and lime next. Drilling cowpeas in corn at the last cultivation has not been profitable, owing partly to the small growth of the cowpeas and to a slight decrease in the yield of corn. A systematic crop rotation should be followed to contain such legume crops as clover, soy beans, or cowpeas, and the feeding of crops and the careful return of the manure, or the use of green manures, should form a part of the system. The following rotations are suggested: Corn, cowpeas or soy beans, wheat, and clover. Corn, wheat, clover, and timothy two years. Corn, cowpeas or soy beans, wheat, and clover and timothy two years. Stock farming, especially dairying, is

[1] See Bul. No. 129, Mo. Agr. Expt. Sta.

highly suited to this region. Pure grain farming is not to be recommended, but mixed farming may be very satisfactory where green manure crops are used in addition to barnyard manure, particularly if grown as cover crops to prevent soil washing.

An acreage application of 150 pounds of bonemeal or 175 to 200 pounds of acid phosphate will give good returns with wheat, although a fertilizer containing 10 to 12 per cent available phosphoric acid and 3 to 5 per cent potash when obtainable will usually give larger immediate profits. Where clover or grass follows the wheat it will also be greatly benefited.

A fertilizer high in phosphates, such as bonemeal or acid phosphate, or a mixed fertilizer containing 2 to 3 per cent nitrogen, 10 to 12 per cent available phosphoric acid, and, when obtainable, 2 to 3 per cent of potash, may be profitable for corn in intensive farming. This should be applied ahead of the planter, with a fertilizer drill, at the rate of 150 to 225 pounds per acre. Rock phosphate may be used as a part of the phosphate application where much organic matter is added to the soil. From 800 to 1,000 pounds per acre may be used once in 6 to 8 years. This should be supplemented with readily available phosphates and, if possible, with some potash before wheat. The nitrogen content of the soil may be maintained by proper crop rotation and manuring.

On the areas whose productiveness has been lowered the use of 2,000 to 4,000 pounds of ground limestone per acre once in every 4 to 6 years will give good results.

LESLIE CLAY LOAM.

The surface soil of the Leslie clay loam is a dark-brown to almost black silt loam grading into a darker colored clay loam at 3 or 4 inches. This is in turn underlain at 10 or 12 inches by a greenish or yellowish-brown clay, somewhat mottled with yellow and dark brown. The clay layer may extend to a depth of 3 feet or more, but in most places it is underlain at 18 to 30 inches below the surface by beds of massive limestone. Only a few small areas of this soil are mapped about 3 miles southeast of Olney. The type is not under cultivation.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Leslie clay loam:

Mechanical analyses of Leslie clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
344642	Soil	0.5	2.5	2.0	10.0	9.2	48.5	27.3
344643	Subsoil	.0	.8	.8	10.9	7.8	49.6	30.3

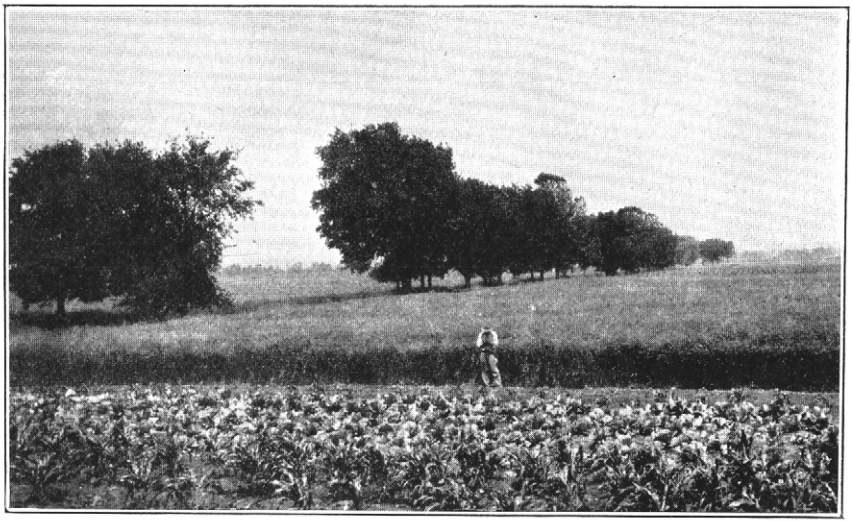


FIG. 1.—FIELD OF WHEAT ON THE LINTONIA SILT LOAM.

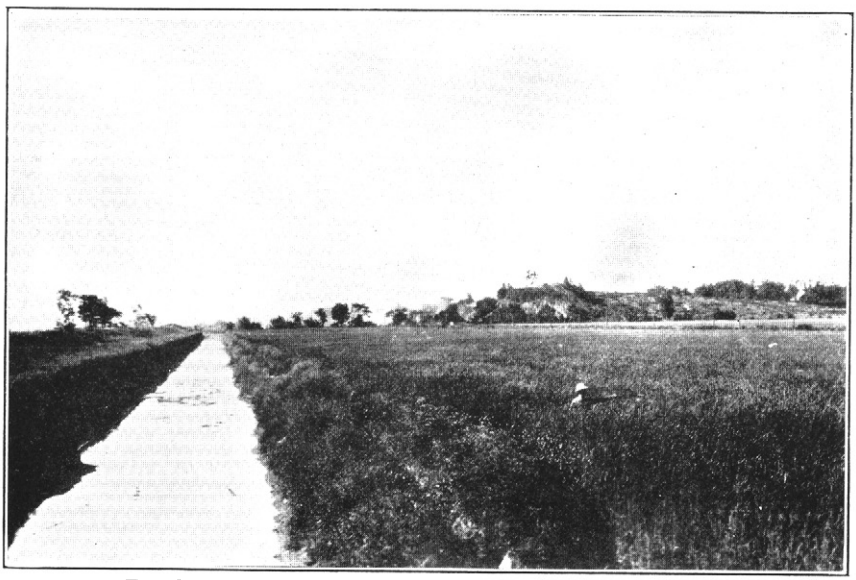


FIG. 2.—DRAINAGE DITCH THROUGH THE WABASH SILT LOAM.

Note the splendid growth of wheat in the adjacent field.

FIG. 1.—CORN ON ARTIFICIALLY DRAINED WABASH CLAY LOAM.

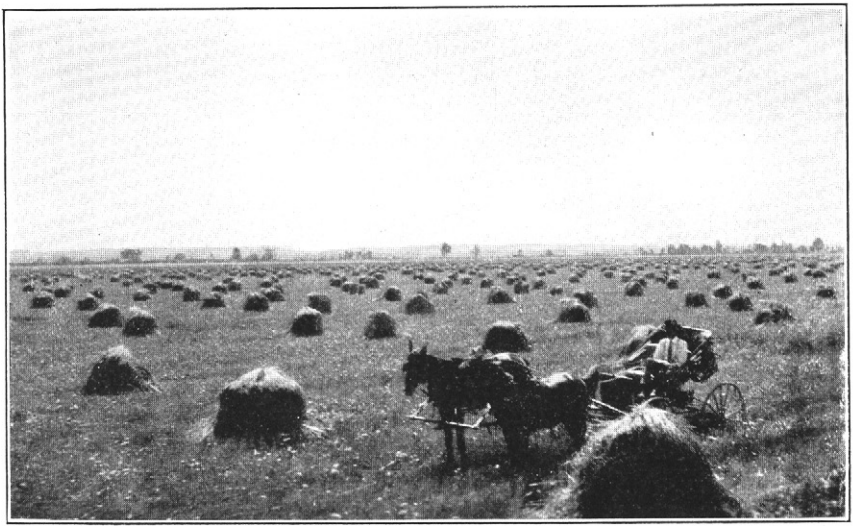


FIG. 2.—FIELD OF WHEAT ON WELL-DRAINED WABASH SOILS.

LINTONIA SILT LOAM.

The soil of the Lintonia silt loam is a light-brown, slightly grayish brown, or yellowish-brown silt loam, smooth in texture and loose and friable. It grades slightly heavier with depth. At about 16 inches the color becomes slightly lighter and in many places slight gray mottlings are noticeable, but in the typical areas no gray layer occurs. This light-brown or grayish-brown silt loam may extend to a depth of 3 feet or more, or may be underlain at less depth by some other material, usually a Wabash soil over which it has been deposited. The lower subsoil may range from silt loam to clay.

The Lintonia silt loam consists largely of material washed from the adjacent hill slopes and dropped where the current of the small streams has been checked upon entering the larger valleys. The type is locally called "made land." The deposits from which it is derived are deepest near the stream channel and thin out away from it. The areas are widest near the outer edge of the main valley and become narrower and the material somewhat finer nearer the river. In several places the channel of the depositing stream has been changed, either through sedimentation or by artificial means, and areas of this soil have been left at a considerable distance from the stream which formed them. In separating this type from the Genesee silt loam along the small stream valleys rather arbitrary lines have been drawn, as in places the difference between the two soils is slight.

The largest areas of Lintonia silt loam occur in the northern part of the Mississippi Valley. East of Dameron a long, narrow strip is mapped along a ditch into which Bryants Creek was at one time diverted. Extending out into the valley at Elsberry is a well-defined delta formed by deposits from Lost Creek, which has now been diverted into a drainage ditch. At Apex a smaller deposit has been made by Hurricane Creek, and at Winfield a similar one by McLean Creek. Other minor areas, some of them only a few acres in extent, lie between Old Monroe and Dameron.

This type is level or very gently sloping. The slope is most pronounced adjacent to the depositing stream. The run-off in places was originally inadequate, as the depositing stream spread out into flat depressions. Through the filling up of these and the diversion of the streams into new channels or into ditches the drainage has been much improved. The underdrainage of the greater part of the type is sufficient and tile drainage for the higher parts has not been found necessary. The type is not subject to overflow from the Mississippi River and it has been protected from overflow from the small streams by levees and by diversion of the streams.

Considering its freedom from overflow, its productiveness, its thorough drainage, its moisture-holding capacity, its ease of cultivation, and wide crop adaptation, this is the most desirable soil in the county. It is practically all under cultivation, almost exclusively to corn and wheat, although it is adapted to all the other common crops. A large acreage is used for clover, which is grown mainly for keeping up the nitrogen and organic supply of the soil. Alfalfa is grown to only a small extent, although this is apparently the best natural alfalfa soil in the county. Corn yields 40 to 75 bushels per acre, averaging around 50 bushels, and wheat 15 to 35 bushels, averaging about 25 bushels. A field of wheat on this soil is shown in Plate II, fig. 1.

The greater part of this type is well farmed. The breaking is thoroughly done and 4 to 6 cultivations are given corn. Commercial fertilizers are used to some extent, principally raw or steamed bone, but some wheat growers depend almost entirely on clover for keeping up the productiveness.

In general this type is well situated near roads and shipping points, and it is held at prices ranging from $125 to $150 or more an acre.

Lintonia silt loam, shallow phase.—The shallow phase of the Lintonia silt loam consists of areas in which the surface soil ranges from 3 to 12 inches in depth. The subsoil is in most cases Wabash clay or clay loam which has been by the processes of cultivation more or less mixed with the surface soil. Some areas of this phase have been thoroughly tile drained and the results have been very satisfactory.

CALHOUN SILT LOAM.

To a depth of 12 to 16 inches the Calhoun silt loam is a light-gray or almost white silt loam. In virgin areas the soil is slightly darker colored at the surface. It is rather heavy, and is loose and flourlike when dry, but sticky and plastic when wet. At 12 to 16 inches this silt loam layer is underlain rather abruptly by a drab, dark-gray or brownish-gray clay loam to clay, mottled with gray and brown. This continues to a depth of about 30 inches, below which the texture becomes silghtly coarser. In many places small iron concretions occur in the surface soil and the upper subsoil.

In the eastern part of the county near Old Monroe, and in the northeastern part near the valley of Bryants Creek, some areas are included in which the surface soil is light brown to yellowish brown and in which the deep subsoil, as shown around the edges of the terrace, resembles that of the Memphis silt loam. The terraces on which this variation occurs are high and the soil seems to be more productive than in the typical areas.

Considerable areas of the Calhoun silt loam occur along the north side of the Cuivre Valley east of Moscow Mills, and smaller areas are

mapped in many places along the smaller stream valleys. In many places there is a narrow strip of this soil at the foot of stream slopes adjacent to the flood plain.

The topography is level or gently sloping toward the stream valley. The type occupies distinct terraces lying from 10 to 40 feet above the flood plains. The run-off, on account of the almost level topography, is in many places inadequate. and the heavy subsoil restricts underdrainage.

This type was originally forested, largely with post oak, bur oak, and some white oak. The greater part of it is under cultivation, wheat, corn, timothy, redtop, oats, and clover being the principal crops. It is a cold, late soil, best suited to wheat, oats, timothy, and redtop. Alsike clover does fairly well on part of the type. In favorable years corn gives fair yields, but if the season is too wet or too dry returns are considerably lower than on the adjacent first-bottom soils.

BUCKNER LOAM.

The surface soil of the Buckner loam is a brown, dark-brown, or almost black sandy loam grading into a loam at 4 to 6 inches. At 12 to 15 inches this becomes lighter brown and grades into a yellowish-brown or reddish-brown sandy clay which continues to a depth of 3 feet or more. Scattered over the surface and through both soil and subsoil are small waterworn pebbles and gravel.

Only one small area of typical Buckner loam is mapped in Lincoln County. This lies about a mile west of Dameron in the valley of Bryants Creek.

In this survey there are included with the Buckner loam small areas which differ from it, but which on account of their limited extent do not warrant separate classification. One of these occupies a high terrace on which part of the town of Elsberry is situated. It has a brown to dark-brown, sandy loam surface soil and a light-brown sandy loam subsoil. In places the lower subsoil is a light-brown sand. At Old Monroe, south and east of Brevator, and at two other places between Brevator and Winfield are high-terrace areas whose surface soil ranges from a brown to black sandy loam to loam, and carries considerable small, waterworn gravel. The subsoil below 15 inches is usually lighter brown and carries large quantities of gravel. Near Brevator gravel from beds in the lower subsoil has been used extensively for railroad ballast. These terrace soils with gravelly subsoil are not very drought resistant. All these high terraces are fragments of old flood plains, and the soils if of sufficient extent would be classed with the Waukesha series.

Included with the type also are numerous small, low ridges and mounds lying in the Mississippi flood plain. These are not true terraces but have been built up by the deposition of coarse material

where conditions have been favorable, as along channels of swift-flowing water. The surface soil of these low ridges is brown to dark brown, and the texture ranges from sandy loam to heavy loam or clay loam. The subsoil is brown or gray, frequently mottled and in some places slightly cemented.

The typical Buckner loam is well suited to all the common crops, and gives good yields. The high terrace areas having very sandy or gravelly subsoil and the ridges in the Mississippi flood plain generally have a lower crop value.

WABASH SILT LOAM.

The Wabash silt loam, to a depth ranging from 8 to 15 inches, is a gray to dark-gray silt loam to clay loam, which appears almost black in some areas when moist. It is fairly loose and friable when in good moisture condition. At 8 to 15 inches the color becomes slightly lighter gray and the texture heavier, ranging from a clay loam to clay, continuing without textural change to the depth of 3 feet or more.

This type is subject to rather wide variations in both color and texture. It consists principally of material washed into the Mississippi bottoms by tributary streams, mixed with material deposited from the flood waters of the Mississippi. The type occurs principally in small areas near the point where a tributary stream enters the Mississippi flood plain and in narrow belts adjoining areas of Lintonia silt loam, as near Dameron, Elsberry, Foley, and Winfield. A few small areas are mapped in the valley of Cuivre River, one about 4 miles southeast of Louisville, and another a mile southwest of Briscoe. Part of the type is well drained, but much of it needs better surface and underdrainage. The type was originally forested, but the greater part of it has been cleared and much of it, on account of its position slightly higher than the surrounding land and the correspondingly reduced danger from overflows, has been under cultivation for many years. Corn and wheat are the principal crops, but clover, oats, timothy, and other crops are grown. Yields average slightly less than on the Lintonia silt loam. Land values range from $75 to $100 an acre.

Where this type has been farmed for a long time it should be built up by growing clover and using it for pasture. Much of the type can be improved by more thorough drainage, either by ditching or laying tile drains. A drainage ditch lying partly in this soil is shown in Plate II, figure 2.

WABASH SILTY CLAY LOAM.

The Wabash silty clay loam consists of a dark-brown or almost black silty clay loam which becomes slightly heavier below 6 inches. At 15 or 16 inches the color becomes slightly lighter, but the texture

remains practically the same to a depth of 36 inches in the typical areas. In many places, however, the subsoil grades slightly lighter below 30 inches ranging from a very fine sandy loam to a heavy silt loam. In this respect these areas approach rather closely to the Sarpy series. Distributed rather uniformly through the entire soil and subsoil section is a relatively large proportion of fine and very fine sand.

This type consists of recent deposits left from annual or more frequent overflows of the Mississippi River, a single overflow often leaving a deposit 1 to 3 inches in thickness. It differs from the other Wabash soils in being a new soil which has undergone less change since its deposition.

The type is subject to considerable variation. Where the surface is nearly level, slightly depressed, or low lying, making conditions favorable for heavy deposits from slowly moving or still water, the soil is heavy in texture, often approaching a clay. Where the areas are high and the deposits have been made by more swiftly moving water, as along the channel side of the islands, they carry a much higher percentage of silt and fine sand.

Areas of Wabash silty clay loam occur adjacent to the Mississippi River channel and on the islands in the river. The largest area lies between the lower part of Kings Lake and the river. The surface is level or slightly sloping away from the streams. The large area between Kings Lake and the river is much dissected by long, narrow channels or lakes. Except during inundations drainage is good, but practically all the type is subject to overflow. If protected from overflow the underdrainage, on account of the deep subsoil of lighter texture, would be sufficient.

Probably not more than one-fourth of this type is under cultivation. It is used almost exclusively for growing corn. Planting is usually delayed until after the "June rise," and even then the crop is frequently injured by overflows. In favorable seasons, however, the yield is large. Where not under cultivation the type is covered with a heavy forest of hardwoods, including walnut, hickory, pecan, sycamore, ash, elm, and oaks of different varieties. Parts of some of the islands and of the mainland around the old lakes and ponds have almost a swamp vegetation consisting of button bush, willow, and other water-loving plants. Swamp grasses and rushes in places cover extensive areas. The uncultivated areas are used to a large extent for pasture. This is inherently the richest soil in the county, but owing to lack of protection from overflow it has a comparatively low value.

WABASH CLAY LOAM.

The soil of the Wabash clay loam is dark-gray when dry, and almost black when moist. It ranges from a heavy silt loam to a clay loam, and grades heavier with depth. At 12 to 15 inches it gives way to a somewhat lighter gray, heavy clay loam, mottled to some extent with yellow and light brown, and carrying in places some small iron concretions. Below 24 inches it usually grades into a heavy, gray clay, but in some places the lower subsoil is dark gray to almost black. Mottlings of light brown, gray, and black are common. This soil is more difficult to handle when either too wet or too dry than the Wabash silt loam, but when in good moisture condition it is fairly friable and easy to cultivate.

The Wabash clay loam is confined to the Mississippi River flood plain, where it is developed around many of the areas of Wabash silt loam. It is intermediate between that type and the Wabash clay. The surface is nearly level, and the natural drainage of much of the type is poor. Much of it is or has been subject to overflow, but in the Elsberry drainage district considerable areas have recently been protected from inundation and improved with tile drains.

Part of this type was originally prairie and supported a dense growth of native grasses. Some areas were forested with a scattering growth, principally water oak and pin oak. The type at present is used for growing corn and wheat and for pasture land. Yields in favorable seasons are good, but on account of the poor drainage crops have been somewhat more uncertain than on the Wabash silt loam. The type can undoubtedly be made much more productive by protection from overflow, thorough surface and internal drainage, the incorporation of organic matter, and, where the soil is to be used for clover, the application of ground limestone. Plate III, figure 1, shows a field of corn on soil of this type which has been well drained. Plate III, figure 2, shows a field of wheat on a well-drained area of Wabash soils.

WABASH CLAY.

The Wabash clay is a dark-gray to bluish-black, heavy, tenacious clay, continuing to a depth of 3 feet or more. It is sticky and plastic when wet and when dry cracks and breaks into small cubelike particles. The subsoil ranges from black to drab or gray, with more or less mottling of brown, yellowish brown, and gray.

Considerable variations occur in this type. Along Kings Lake and near other long lakes and drainage ways there are areas, frequently occupying low, broad ridges, in which the surface soil has a dull-brownish tinge and the subsoil below 12 to 15 inches is a light-gray, heavy, tenacious, fairly uniform clay to a depth of 3 feet or more.

Both color and texture vary somewhat throughout the type, but as a whole it is dark in color and heavy in texture.

The Wabash clay occurs in a broad belt occupying the central and lower part of the Mississippi flood plain between the slightly higher land near the river and the Lintonia silt loam along the outer edge of the valley. From a point near the northern border of the county almost to the pumping station east of Apex, this belt has an approximate width of 2 miles. South of this point it becomes narrower and is more or less broken up into isolated areas. A small body of soil in the valley of Bryants Creek is included with this type, although it is not of the same origin.

The Wabash clay is practically level except where low ridges occur along the drainage ways, and formerly the type was not only subject to overflow from the Mississippi River, but was saturated with water carried into the valley by tributary streams. Recently the greater part of the type has been protected from overflow by levees, the tributary streams have been turned into large ditches also protected by levees, and open ditches have been constructed to carry off the natural rainfall and afford an outlet for tile drains. Surplus water in the Elsberry district is carried into the Mississippi River through the lower course of Kings Lake, the drainage being by gravity during normal or low stages of the river. During high stages pumping is resorted to. During the last two years many hundred acres of this land have been thoroughly tile drained, at an outlay ranging from $15 to more than $25 an acre. These areas have not been drained sufficiently long to demonstrate the results under varying seasonal conditions, but from results obtained under similar soil and climatic conditions in other places it is believed they will prove satisfactory.

The greater part of this type originally supported a dense growth of swamp grass, much of which remains and is used for pasture or cut over for hay. In subduing this soil its refractory nature and the difficulty of breaking up the tough-rooted grass make it necessary to use heavy teams or tractors. Parts of the type, especially where it extends almost to the river and along the drainage ways, support a forest growth consisting largely of water oak and pin oak but in places including pecan, hickory, elm, maple, ash, and other trees.

Parts of this type have been under cultivation for many years, and in favorable seasons excellent crops of corn and wheat are produced, but owing to the difficulty of putting it under cultivation and keeping it in good tilth, and to the uncertainty of crop yields as a result of poor drainage conditions, it was not held in very high regard. Wheat is preferred to corn. At the present time about one-half of the type is under cultivation. Yields under the poor drainage conditions of the past have varied widely, from almost nothing to 35

bushels of wheat or 75 bushels of corn per acre. Where the land is not tile-drained prices range from $50 to over $75 an acre. The application of lime would improve the texture of this soil.

WAVERLY SILT LOAM.

The soil of the Waverly silt loam is a light-gray or almost white silt loam which at 8 or 10 inches becomes more distinctly white but mottled with some dark gray and brown. At about 20 inches this grades into a distinctly heavier silt loam to clay loam, mottled with brown and black, which gradually changes to a clay loam or clay. This type differs from the gray-subsoil phase of the Genesee silt loam principally in its lighter colored surface soil. It is also as a whole slightly less productive.

The Waverly silt loam occurs principally in the first bottoms of Cuivre River and Lead Creek. It is subject to overflow, but at less frequent intervals than the Genesee silt loam. Crop adaptations, yields, and land values are intermediate between those of the lower lying Genesee silt loam and the slightly higher lying Calhoun silt loam. Much of the type occurs on low terraces subject to overflow only during periods of unusually high water.

GENESEE FINE SANDY LOAM.

The Genesee fine sandy loam consists of a gray to brownish-gray fine sandy loam, usually grading at 12 to 15 inches into a heavy fine sandy loam or silt loam. The type lacks uniformity. In many places it includes areas of sandy loam or silt loam, and the subsoil in many places carries a high percentage of waterworn gravel.

The principal areas of this type occur in the valley of Big Creek. The sandy areas usually lie adjacent to the stream channel. In the Mississippi flood plain a few narrow strips next the river channel both on the mainland and on some of the islands are included with this type.

The greater part of the Genesee fine sandy loam is subject to overflow. It is used almost entirely in growing corn. The yields are not usually quite so good as on the adjacent soils that are higher in silt.

GENESEE SILT LOAM.

The Genesee silt loam has a surface soil of grayish-brown, very fine sandy loam to coarse silt loam grading at 3 or 4 inches into a coarse silt loam of the same color. At 12 to 15 inches a few mottlings of light gray are found. This slight mottling extends to a depth of about 20 inches, below which the subsoil may be somewhat heavier or may continue with little change in color or texture to a depth of 30 inches or more.

As mapped, this type includes rather wide variations. In color it varies from light gray, especially along the small streams which head well out into the areas of typical Putnam soils, to almost black, where the deposits have included much material from beds of limestone. It includes many small areas of fine sandy loam, sandy loam, and gravelly loam, especially near the channels of small streams having their source in areas of Lindley or Hagerstown soils. In large areas of the type gravelly loam or extensive beds of almost pure gravel are found in the lower subsoil. Along the larger streams the greater part of the type is alluvial, but in many places along the outer edge of these broader valleys strips of colluvial material and small deltas from tributary streams are included. Along the small streams much of the material is colluvial, having been gradually moved down the slopes of the adjacent hills. In many places small terraces of light-colored soils having a heavy clay subsoil are, on account of their limited extent, included with the Genesee silt loam.

Extensive level areas of Genesee silt loam occur along Cuivre River and all the smaller streams, and include low terraces, gradual slopes, and small deltas. Much of the type is subject to occasional overflow, and some of the lower areas are inundated almost every year, but otherwise the drainage is good. Areas containing an excess of gravel in the subsoil are not very drought resistant, and crops here frequently suffer in dry periods.

The low-lying areas are devoted almost entirely to corn, while on the higher areas wheat and clover are grown to a greater extent. Alfalfa is raised in a small way. Corn yields from 40 to over 60 bushels per acre and wheat from 15 to over 30 bushels. Land values on the better areas of the type range from $75 to $100 an acre.

Genesee silt loam, gray-subsoil phase.—The gray-subsoil phase of the Genesee silt loam consists of a dark-gray to brownish-gray silt loam of almost the same color and texture as the typical soil. At 6 to 10 inches mottlings of gray become noticeable and increase with depth until the entire subsoil layer consists of a light-gray silt loam. At 16 to 20 inches this grades into a light-colored, heavy silt loam or clay loam, which is less impervious than the heavy layer of the Calhoun silt loam.

This phase occurs on low terraces subject to overflow and in poorly drained flat areas, which in places are slightly depressed or basin-like. The phase is intermediate between the typical Genesee and Wabash silt loams and the Calhoun silt loam. The gray subsoil color and the heavy layer are due, in part at least, to the aging of the soil on level areas in the same way that other level soils age, but is also due in some cases to poor underdrainage. In many places the difference between this phase, the Calhoun silt loam, and the

Waverly silt loam is slight, these soils grading into each other almost imperceptibly. As a whole this phase of the Genesee is the most productive of the three soils.

Large areas of this phase are mapped in the Mississippi bottoms and smaller areas in the bottom lands along the Cuivre River. It is used extensively for corn and wheat, and good yields are obtained, under favorable conditions, but crops suffer more readily from either drought or from excessive rainfall than on the typical Genesee silt loam or on the Lintonia silt loam. In the Mississippi bottoms large areas of this soil are being tile drained.

ROUGH STONY LAND.

Rough stony land includes rock ledges and steep, rocky slopes on which there is practically no tillable soil and little land suitable for grazing. It occurs principally in narrow strips bordering the larger valleys, in many places on both sides of the stream. The principal areas are mapped along Cuivre River and its larger tributaries. In the eastern part of the county there are included with this type the crests of two ranges of high hills, one north and the other south of Lost Creek. The greater part of these latter areas, on account of their steep slope and rocky character, is nonagricultural, but they include some small areas which are of agricultural value and if of greater extent would be classed as Hagerstown or Memphis silt loam.

SUMMARY.

Lincoln County lies in the eastern part of Missouri, about 40 miles northwest of St. Louis. It has an area of 607 square miles or 388,480 acres. The county includes nearly level and gently rolling prairies, undulating hilly and broken areas, and level stream flood plains and terraces.

The eastern part of the county is drained directly into the Mississippi River by several small tributary streams. The remainder is drained by Cuivre River and its numerous tributaries.

Permanent settlement in this territory began more than 100 years ago. In 1910 the population was 17,033. It is all classed as rural and averages 28.1 persons per square mile. Elsberry and Troy are the largest towns.

Good transportation facilities are afforded by three lines of railroad and by good public roads which reach into nearly every part of the county. Privately owned toll roads radiate from Elsberry, Troy, and Silex.

The agriculture of Lincoln County consists largely of stock raising and feeding, combined with grain farming, and dairying.

The form of agriculture practiced tends to maintain the productiveness of the soils, although in parts of the county they have suffered from continuous cropping to corn and wheat and from soil erosion.

Corn, the most important crop, is used almost entirely for stock feeding. Wheat is grown quite extensively on the bottom lands and on the hill lands in the eastern part of the county, and to a smaller extent on the level prairies. Oats are a more important crop on the prairie soils than in other parts of the county. Clover is grown throughout the greater part of the county. Other important crops are timothy and bluegrass. Apples, small fruits, and garden truck are grown in a small way.

There is a rather wide range in the soils of Lincoln County. They may be divided into five broad groups, viz: Nearly level prairie soils with heavy clay subsoil; brown hill soils not greatly eroded; eroded hill soils; light-brown and reddish-brown hill soils, and bottom-land soils. In origin the soils are glacial, loessial, residual, or alluvial.

The Putnam silt loam, the upland prairie soil, is largely glacial in origin. It is in a fair state of productiveness. This soil is used largely for growing corn, oats, wheat, timothy, and to some extent clover. It furnishes good bluegrass pastures.

The Marion silt loam is closely related to the Putnam, but is older in stage of development. It is a forested soil, less productive than the Putnam.

The Lindley loam and silt loam and the eroded phase of the latter are glacial types having light-brown surface soils and a heavy sandy clay subsoil. They are suited to clover, corn, wheat, and all the other common crops, but are not highly productive naturally.

The Clinton silt loam differs from the Memphis in its lighter color and heavier subsoil, and in being somewhat less productive.

The Memphis silt loam, which is partly of loessial origin, is one of the best wheat and clover soils of the uplands. It is also suited to the growing of apples, small fruits, and garden truck. In certain sections of the United States soil of this type is used extensively for growing tobacco.

The Hagerstown silt loam is the principal residual soil of the county. It is well suited to all the common crops. Large areas of the stony loam are of use principally for pasture.

The Genesee soils occur in the first bottoms of the small streams and also cover considerable areas in the Mississippi bottoms. Two types, the silt loam and fine sandy loam, are recognized.

The Wabash soils are developed principally in the first bottoms of the Mississippi River. Considerable areas of these soils have been protected from overflow and are being drained by open ditches and

tile. They are naturally very productive. Four types are recognized, the silt loam, silty clay loam, clay loam, and clay.

The Lintonia silt loam is composed principally of wash from the loess-covered hills carried down and deposited in the Mississippi flood plain. It is not a very extensive type, but is one of the most productive in the county.

The Waverly silt loam is a first-bottom soil of small extent occurring principally in the flood plain of Cuivre River.

Two series of second-bottom soils are recognized. The light-gray soil with a heavy subsoil is correlated as the Calhoun silt loam, and the brown, somewhat gravelly soil as the Buckner loam.

○

[PUBLIC RESOLUTION.—No. 9.]

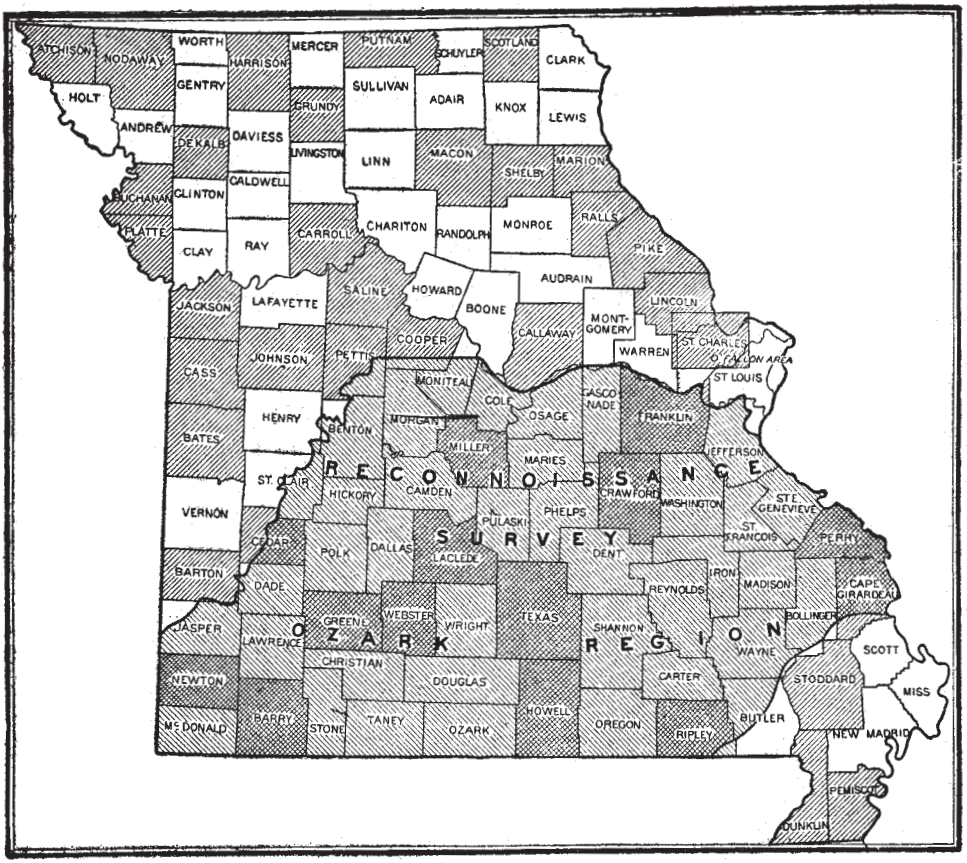
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided,* That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the Congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]



Areas surveyed in Missouri.

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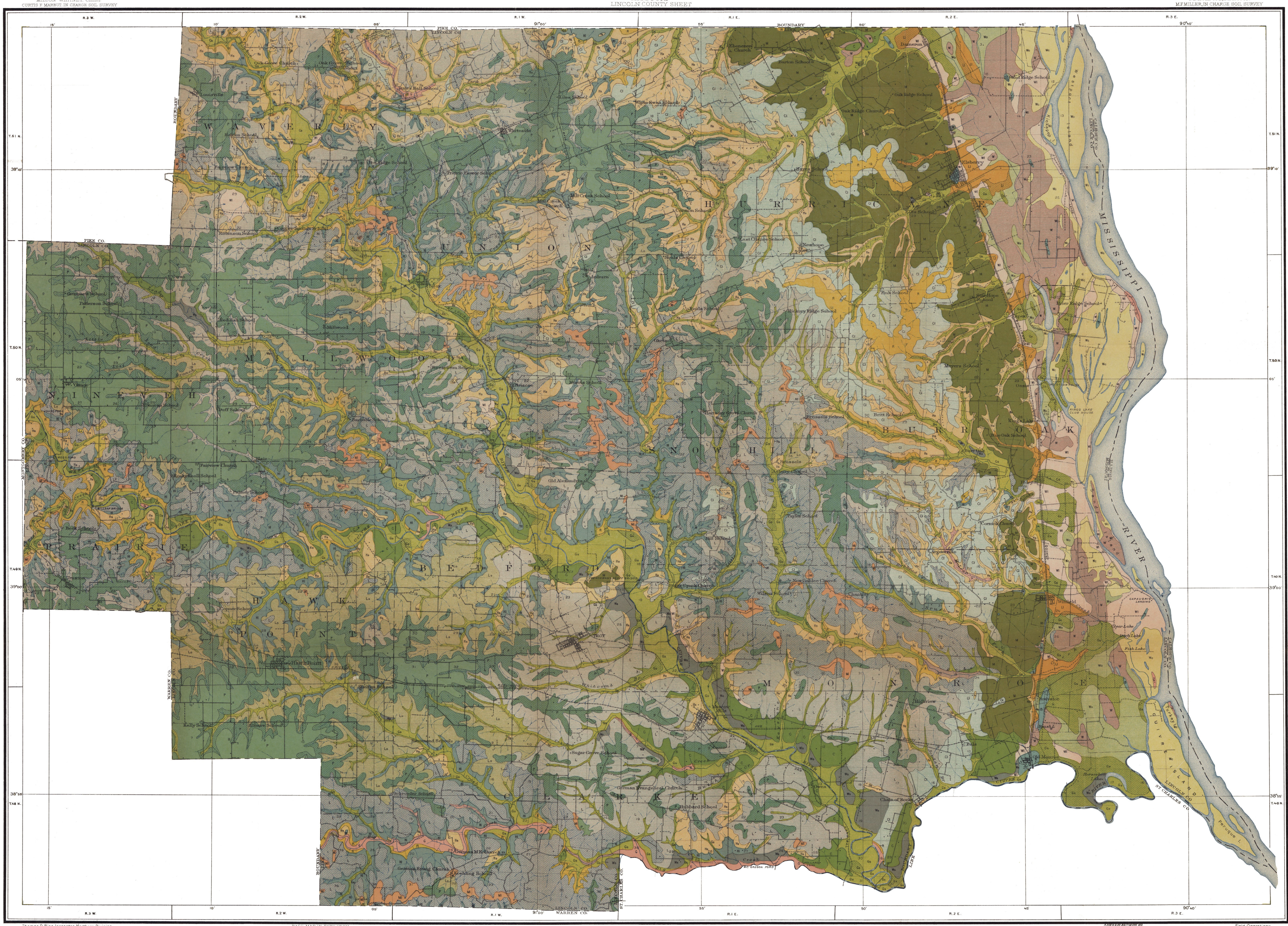
U.S. DEPT OF AGRICULTURE
BUREAU OF SOILS
MILTON WHITNEY, CHIEF
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

SOIL MAP
MISSOURI
LINCOLN COUNTY SHEET

UNIVERSITY OF MISSOURI
AGRICULTURAL EXPERIMENT STATION
F.B. MUMFORD, DIRECTOR
M.F. MILLER, IN CHARGE SOIL SURVEY



LEGEND

Putnam silt loam (P)	Lintonia silt loam (Li)
Rolling phase (P)	Shallow phase (Li)
Marion silt loam (Ml)	Wabash silt loam (Wl)
Lindley loam (Lo)	Wabash clay loam (Wo)
Lindley silt loam (L)	Wabash silty clay loam (Wc)
Eroded phase (L)	Wabash clay (W)
Hagerstown stony loam (Hl)	Genesee fine sandy loam (G)
Hagerstown silt loam (Hs)	Genesee silt loam (Gs)
Leslie clay loam (Lc)	Gray subsoil phase (Gs)
Memphis silt loam (M)	Waverly silt loam (Ws)
Clinton silt loam (Cl)	Calhoun silt loam (C)
Buckner loam (B)	Rough stony land (R)

CONVENTIONAL SIGNS

CULTURE
(Printed in black)

City or Village, Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort
Secondary roads and Trails
Railroads Steam and Electric
Bridges, Ferry
R.R. crossings, Tunnel
Ford, Dam
School or Church, Cemeteries
Mine or Quarry, Mine dumps, Made land
Bluff, Escarpment, Rock outcrop and Triangulation station
Stony and Gravelly areas
Soil boundaries
Boundary lines
Boundary lines
Boundary lines
U.S. township and section lines

RELIEF
(Printed in brown or black)

Contours, Depression contours
Prominent Hills, Mountain Peaks
Sand, Wash and Sand dunes
Shore and Low water line, Sandbar

DRAINAGE
(Printed in blue)

Streams
Lakes, Ponds, Intermittent lakes
Intermittent streams
Springs, Canals and Ditches, Flumes
Swamp, Salt marshes
Submerged marsh, Tidal flats

The above signs are in current use on the soil maps. Variations from this usage appear in some maps of earlier dates.

Thomas D. Rice, Inspector, Northern Division.
Soils surveyed by A.T. Sweet, in charge, and H.W. Hawker, of the U.S. Department of Agriculture, and E.W. Knobel and J.B. Fehsenfelt of the University of Missouri.

BASE MAP IN PART FROM
U.S. GEOLOGICAL SURVEY SHEETS

1 ½ 0 1 2 3 4 Miles
Scale 1 inch = 1 mile

A. HOEN & CO. BALTIMORE, MD.

Field Operations
Bureau of Soils
1917.